

ÉRETTSÉGI VIZSGA • 2006. május 18.

**ELEKTRONIKAI ALAPISMERETEK
ANGOL NYELVEN
FOUNDATIONS IN ELECTRONICS**

**EMELT SZINTŰ ÍRÁSBELI
ÉRETTSÉGI VIZSGA
ADVANCED LEVEL WRITTEN
BACCALAUREATE
EXAMINATION**

**JAVÍTÁSI-ÉRTÉKELÉSI
ÚTMUTATÓ
CORRECTION-EVALUATION
GUIDE**

**OKTATÁSI MINISZTERIUM
MINISTRY OF EDUCATION**

Solutions of test questions

Maximum points: 40

- 1.) The table expresses the voltage dependence of power of an ohmic resistance. The value of the resistor does not change. Fill in the table.

U (V)	1	2	4	8	16
P (W)	0.125	0.5	2	8	32

4 points

- 2.) Define the direct current resistance at a temperature of $T_1' = 20\text{ }^\circ\text{C}$ of a coil of $R_1 = 10\ \Omega$ at a temperature of $T_2 = 60\text{ }^\circ\text{C}$. The temperature coefficient: $\alpha = 0.004\text{ }^\circ\text{C}^{-1}$.

$$R_2 = R_1 \cdot \left[1 + \alpha \cdot (T_2 - T_1') \right] = 10\ \Omega \cdot \left[1 + 0.004 \frac{1}{^\circ\text{C}} \cdot (60^\circ\text{C} - 20^\circ\text{C}) \right] = \underline{\underline{11.6\ \Omega}} \quad 3 \text{ points}$$

- 3.) In the case of being charged with constant current, define the voltage of a capacitor after full discharge at time $t = 60\text{ s}$ elapsed from the beginning of charging. Data: $C = 2\ \mu\text{F}$, $I = 1\ \mu\text{A}$.

$$U = \frac{Q}{C} = \frac{I \cdot t}{C} = \frac{1\ \mu\text{A} \cdot 60\text{ s}}{2\ \mu\text{F}} = \underline{\underline{30\text{ V}}} \quad 3 \text{ points}$$

- 4.) The table expresses the frequency dependence of a current of inductivity. The effective value of the voltage does not change. Fill in the table.

f (Hz)	100	200	400	800	1600
I (mA)	240	120	60	30	15

4 points

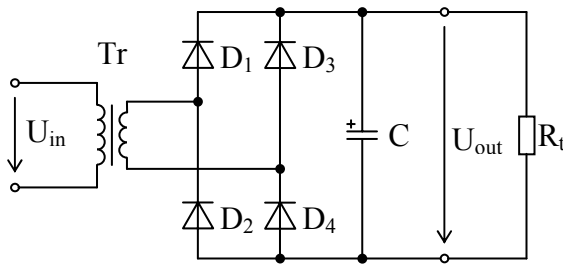
- 5.) Define the momentary value of $U_{\text{eff}} = 1\text{ V}$, $f = 1\text{ kHz}$ sinusoidal alternating voltage at $t = 100\ \mu\text{s}$ that elapsed from the beginning of the period.

$$u = \sqrt{2} \cdot U_{\text{eff}} \cdot \sin 2 \cdot \pi \cdot f \cdot t = \sqrt{2} \cdot 1\text{ V} \cdot \sin 360^\circ \cdot 10^3 \frac{1}{\text{s}} \cdot 10^{-4}\text{ s} = \underline{\underline{0.83\text{ V}}} \quad 4 \text{ points}$$

- 6.) Define the impedance of an RL parallel combination.
Data: $R = 30\ \Omega$, $X_L = 40\ \Omega$

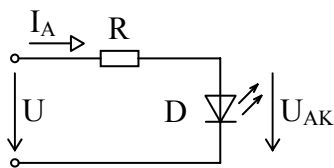
$$Z = \frac{R \cdot X_L}{\sqrt{R^2 + X_L^2}} = \frac{30\ \Omega \cdot 40\ \Omega}{\sqrt{(30\ \Omega)^2 + (40\ \Omega)^2}} = \underline{\underline{24\ \Omega}} \quad 4 \text{ points}$$

- 7.) Draw the circuit diagram of a Graetz rectifier. The circuit diagram should also contain a transformer, a buffer capacitor and a load resistor.



3 points

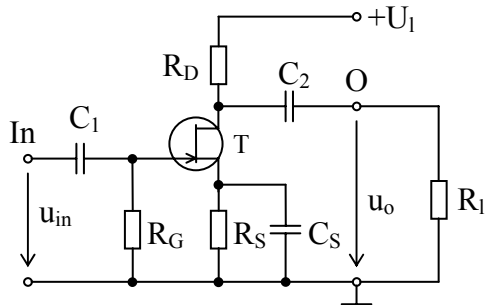
- 8.) Calculate the value of resistor R. Data: $U = 6\text{ V}$, $U_{AK} = 1.6\text{ V}$, $I_A = 20\text{ mA}$.



$$R = \frac{U - U_{AK}}{I_A} = \frac{6\text{V} - 1.6\text{V}}{20\text{mA}} = \underline{\underline{220\Omega}}$$

3 points

- 9.) Draw the basic connection of the common source amplifier. The connection should contain 1 N-channel N-FET, 3 resistors and 3 capacitors.



3 points

- 10.) Calculate the input voltage (U_{in}) of the amplifier with input resistance $R_{in} = 100\text{ k}\Omega$ if the controlling signal source bears unloaded voltage $U_g = 30\text{ mV}$ and internal resistance $R_g = 50\text{ k}\Omega$.

$$U_{be} = U_g \cdot \frac{R_{be}}{R_{be} + R_g} = 30\text{mV} \cdot \frac{100\text{k}\Omega}{100\text{k}\Omega + 50\text{k}\Omega} = \underline{\underline{20\text{mV}}}$$

3 points

- 11.) Supply the algebraic form of the two variable EQUIVALENCE function, and fill in the missing figures in the truth table below.

$$F^2 = A \cdot B + \bar{A} \cdot \bar{B}$$

A	B	F ²
0	0	1
0	1	0
1	0	0
1	1	1

3 points

- 12.) Give the algebraic form of the logic function below. Mark variable of the most significant place-value with “A”.

$$F^4 = \Pi^4(0, 4, 5, 8, 12)$$

$$F^4 = (\bar{A} + \bar{B} + \bar{C} + \bar{D}) \cdot (\bar{A} + B + \bar{C} + \bar{D}) \cdot (\bar{A} + B + \bar{C} + D) \cdot (A + \bar{B} + \bar{C} + \bar{D}) \cdot (A + B + \bar{C} + \bar{D})$$

3 points

Tasks

Maximum points: 60

Solution of task 1

Maximum points: 15

a) $H_{11} = \left. \frac{U_1}{I_1} \right|_{U_2 = 0}$

$$H_{11} = R_1 + (R_2 \times R_3) = 100 \Omega + (200 \Omega \times 300 \Omega) = \underline{\underline{220 \Omega}} \quad \text{2 points}$$

$$H_{12} = \left. \frac{U_1}{U_2} \right|_{I_1 = 0}$$

$$H_{12} = \frac{U_2 \frac{R_2}{R_2 + R_3}}{U_2} = \frac{R_2}{R_2 + R_3} = \frac{200 \Omega}{200 \Omega + 300 \Omega} = \underline{\underline{0.4}} \quad \text{2 points}$$

$$-H_{21} = \left. \frac{I_2}{I_1} \right|_{U_2 = 0}$$

$$H_{21} = -\frac{I_1 \frac{R_2}{R_2 + R_3}}{I_1} = -\frac{R_2}{R_2 + R_3} = -\frac{200 \Omega}{200 \Omega + 300 \Omega} = \underline{\underline{-0.4}} \quad \text{2 points}$$

$$H_{22} = \left. \frac{I_2}{U_2} \right|_{I_1 = 0}$$

$$H_{22} = \frac{1}{R_2 + R_3} = \frac{1}{200 \Omega + 300 \Omega} = \underline{\underline{2 \text{ mS}}} \quad \text{2 points}$$

b) $R_{ki} = [(R_g + R_1) \times R_2] + R_3$

$$R_{ki} = [(100 \Omega + 100 \Omega) \times 200 \Omega] + 300 \Omega = \underline{\underline{400 \Omega}}$$

In the case of matched load: $R_1 = R_{out} = 400 \Omega$ **3 points**

c) $U_2 = U_g \cdot \frac{R_2 \times (R_3 + R_t)}{[R_2 \times (R_3 + R_t)] + R_g + R_1} \cdot \frac{R_t}{R_3 + R_t}$

$$U_2 = 2 \text{ V} \cdot \frac{200 \Omega \times (300 \Omega + 400 \Omega)}{[200 \Omega \times (300 \Omega + 400 \Omega)] + 100 \Omega + 100 \Omega} \cdot \frac{400 \Omega}{300 \Omega + 400 \Omega}$$

$$U_2 = \underline{\underline{0.5 \text{ V}}} \quad \text{4 points}$$

Solution of task 2

Maximum points: 15

a) $f_o = \frac{1}{2\pi\sqrt{L \cdot C}}$

$$C = \frac{1}{4 \cdot \pi^2 \cdot f_o^2 \cdot L} = \frac{1}{4 \cdot \pi^2 \cdot (10^6 \text{ Hz}^2) \cdot 1.5 \cdot 10^{-4} \text{ H}} = \underline{\underline{168.9 \text{ pF}}}$$

2 points

b) $X_L = 2 \cdot \pi \cdot f_o \cdot L = 2 \cdot \pi \cdot 10^6 \text{ Hz} \cdot 1.5 \cdot 10^{-4} \text{ H} = 942.5 \Omega$

2 points

$$Q = \frac{R}{X_L} = \frac{80 \text{ k}\Omega}{0.9425 \text{ k}\Omega} = \underline{\underline{84.9}} \quad B = \frac{f_o}{Q} = \frac{1000 \text{ kHz}}{84.9} = \underline{\underline{11.8 \text{ kHz}}}$$

2 points

c) $I_R = \frac{U}{R} = \frac{400 \text{ mV}}{80 \text{ k}\Omega} = \underline{\underline{5 \mu\text{A}}} \quad I = I_R = \underline{\underline{5 \mu\text{A}}}$

2 points

$$I_L = \frac{U}{X_L} = \frac{400 \text{ mV}}{0.9425 \text{ k}\Omega} = \underline{\underline{424.4 \mu\text{A}}} \quad I_C = I_L = \underline{\underline{424.4 \mu\text{A}}}$$

2 points

d) $Q' = \frac{f_o}{B'} = \frac{1000 \text{ kHz}}{20 \text{ kHz}} = 50 \quad R' = Q' \cdot X_L = 50 \cdot 0.9425 \text{ k}\Omega = 47.1 \text{ k}\Omega$

2 points

$$\frac{1}{R'} = \frac{1}{R} + \frac{1}{R_p} \Rightarrow R_p = \frac{R \cdot R'}{R - R'} = \frac{80 \text{ k}\Omega \cdot 47.1 \text{ k}\Omega}{80 \text{ k}\Omega - 47.1 \text{ k}\Omega} = \underline{\underline{114.5 \text{ k}\Omega}}$$

3 points

Solution of task 3

Maximum points: 15

a)
$$I_{B0} = \frac{I_{C0}}{\beta} = \frac{1 \text{ mA}}{200} = \underline{\underline{5 \mu\text{A}}}$$

$$R_C = \frac{U_t - U_{CE0} - U_E}{I_{C0}} = \frac{12 \text{ V} - 5 \text{ V} - 2 \text{ V}}{1 \text{ mA}} = \underline{\underline{5 \text{ k}\Omega}}$$
 2 points

$$R_E = \frac{U_E}{I_{C0} + I_{B0}} = \frac{2 \text{ V}}{1 \text{ mA} + 0.005 \text{ mA}} \cong \underline{\underline{2 \text{ k}\Omega}}$$
 1 point

$$R_{B1} = \frac{U_t - U_{BE0} - U_E}{11 \cdot I_{B0}} = \frac{12 \text{ V} - 0.6 \text{ V} - 2 \text{ V}}{11 \cdot 5 \mu\text{A}} = \underline{\underline{171 \text{ k}\Omega}}$$
 2 points

$$R_{B2} = \frac{U_E + U_{BE0}}{10 \cdot I_{B0}} = \frac{2 \text{ V} + 0.6 \text{ V}}{10 \cdot 5 \mu\text{A}} = \underline{\underline{52 \text{ k}\Omega}}$$
 1 point

b)
$$R_{in} = R_{B1} \times R_{B2} \times h_{11E} = 171 \text{ k}\Omega \times 52 \text{ k}\Omega \times 4 \text{ k}\Omega = \underline{\underline{3.64 \text{ k}\Omega}}$$
 2 points

$$R_{out} = \frac{1}{h_{22E}} \times R_C = \frac{1}{25 \mu\text{S}} \times 5 \text{ k}\Omega = \underline{\underline{4.44 \text{ k}\Omega}}$$
 2 points

c)
$$A_u = -\frac{h_{21E}}{h_{11E}} (R_{in} \times R_l) = -\frac{200}{4 \text{ k}\Omega} (4.44 \text{ k}\Omega \times 5 \text{ k}\Omega) = \underline{\underline{-117.6}}$$
 2 points

d)
$$u_{in} = u_g \frac{R_{in}}{R_g + R_{in}} = 5 \text{ mV} \frac{3.64 \text{ k}\Omega}{0.5 \text{ k}\Omega + 3.64 \text{ k}\Omega} = \underline{\underline{4.4 \text{ mV}}}$$
 2 points

$$u_{out} = A_u \cdot u_{in} = -117.6 \cdot 4.4 \text{ mV} = \underline{\underline{-517.4 \text{ mV}}}$$
 1 point

Solution of task 4

Maximum points: 15

a)

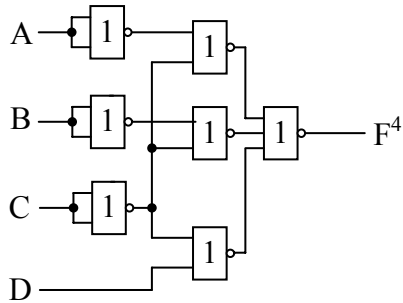
	C				
A	15	14	12	1 ₁₃	B
	11	10	1 ₈	1 ₉	
	3	2	1 ₀	1 ₁	
	7	6	1 ₄	1 ₅	
	D		D		

$$F^4 = (\overline{A+C}) \cdot (\overline{B+C}) \cdot (\overline{C+D})$$

4 points

b)

$$F^4 = (\overline{A+C}) \cdot (\overline{B+C}) \cdot (\overline{C+D}) = \overline{\overline{A+C} \cdot \overline{B+C} \cdot \overline{C+D}} = \overline{\overline{A+C} + \overline{B+C} + \overline{C+D}}$$



3 points

c)

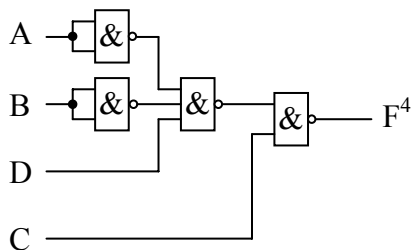
	C				
A	1 ₀	1 ₁	1 ₃	2	B
	1 ₄	1 ₅	7	6	
	1 ₁₂	1 ₁₃	15	14	
	1 ₈	1 ₉	11	10	
	D				

$$F^4 = \Sigma^4(0, 1, 3, 4, 5, 8, 9, 12, 13) \quad \mathbf{2 \text{ points}}$$

$$F^4 = \overline{C} + \overline{A} \cdot \overline{B} \cdot D \quad \mathbf{2 \text{ points}}$$

d)

$$F^4 = \overline{C} + \overline{A} \cdot \overline{B} \cdot D = \overline{\overline{\overline{C} + \overline{A} \cdot \overline{B} \cdot D}} = \overline{C \cdot \overline{\overline{A} \cdot \overline{B} \cdot D}}$$



4 points

Rules Governing the Evaluation of the Written Exam

Evaluation of the solutions of the test questions and other tasks must be carried out in line with the centrally compiled correction and evaluation guide.

Information about the maximum points available for individual test questions and other tasks is contained in the document entitled Solutions of the Written Exam of the Professional Preparatory Baccalaureate. When evaluating solutions of tasks also requiring calculation (sizing), actual points should be allocated in line with the table below:

Quantitative aspects		Qualitative aspects		Documentation of the solution	
Areas of assessment	Ratio	Areas of assessment	Ratio	Areas of assessment	Ratio
<ul style="list-style-type: none"> completeness of solution 	70%	<ul style="list-style-type: none"> logic of the solution creativity accuracy proper use of units of measurement 	20%	<ul style="list-style-type: none"> arrangement layout use of standard symbols conformity to technical, aesthetical and format-related requirements 	10%

In light of the above, maximum points can only be granted if requirements concerning quantitative aspects, qualitative aspects and the documentation of the solution are fully satisfied.

Scoring of test questions

Question 1 (4 points)

Actual points equal the number of correct answers. Minimum 0 points, maximum 4 points.

Question 2 (3 points)

1 point for formula, 1 point for substitution, 1 point for result.

Question 3 (3 points)

1 point for formula, 1 point for substitution, 1 point for result.

Question 4 (4 points)

Actual points equal the number of correct answers. Minimum 0 point, maximum 4 points.

Question 5 (4 points)

2 points for formula, 1 point for substitution, 1 point for result.

Question 6 (4 points)

2 points for formula, 1 point for substitution, 1 point for result.

Question 7 (3 points)

2 points for professionally correct circuit diagram, 1 point for the use of standard symbols.

Question 8 (3 points)

1 point for formula, 1 point for substitution, 1 point for result.

Question 9 (3 points)

2 points for professionally correct circuit diagram, 1 point for the use of standard symbols.

Question 10 (3 points)

1 point for formula, 1 point for substitution, 1 point for result.

Question 11 **(3 points)**

1 point for proper algebraic form, 2 points for the truth table.

Question 12 **(3 points)**

3 points for accurate algebraic form. 1-point deduction for each error; points can be deducted as long as a total of zero point is reached.

The General Rules Governing the Quantitative Evaluation of Tasks

Professionally correct solutions not appearing in the evaluation guide must equally be accepted and allocated the indicated number of points.

Maximum points for a task (part of the task) can only be allocated for the examinee if the data are properly substituted in the formula, and further, if the final result is calculated accordingly.

In certain cases, the use of normal form data should be required.

The final result can only be deemed acceptable if the value and the unit of measurement of the final result are appropriate.

The minimum point that can be awarded for part of a task is 1 point, fewer than 1 point cannot be awarded in any case.

Concerning related parts of one task, in the event that the result of any part of the given task is incorrect and if this incorrect result is used in any subsequent parts of the given task (parts of the task), the points indicated for the correct solution appearing in the guide should be awarded provided the solution is otherwise correct.

Nevertheless, as appropriate, the following will result in deduction of points:

- the partial result used in any subsequent parts of the task is professionally impossible or extreme,
- the partial result used leads to decreased complexity of problem solving in the case of subsequent part or parts of the given task.

Scoring of the tasks

Task 1

Maximum points: 15

- a) In case of each parameter, formula: 1 point, substitution and result: 1 point. In the case of the four parameters **8 points** altogether.
- b) Formula: 1 point, substitution: 1 point, the determination of R_t : 1 point, **3 points** altogether.
- c) Formula: 2 points, substitution: 1 point, result: 1 point, **4 points** altogether.

Task 2

Maximum points: 15

- a) Formula: 1 point, substitution and result: 1 point, **2 points** altogether.
- b) When determining X_L , the formula: 1 point, substitution and result: 1 point, altogether **2 points**.
Determination of Q: 1 point, determination of B: 1 point, **2 points** altogether.
- c) Determination of I_R : 1 point, determination of I: 1 point, **2 points** altogether.
Determination of I_L : 1 point, determination of I_C : 1 point, **2 points** altogether.
- d) Determination of Q' : 1 point, determination of R' : 1 point, **2 points** altogether.
When calculating R_p , formula: 1 point, substitution: 1 point, result: 1 point, **3 points** altogether.

Task 3

Maximum points: 15

- a) When calculating R_C , formula: 1 point, substitution and result: 1 point, **2 points** altogether.
Determination of R_E : **1 point**.
When calculating R_{B1} , formula: 1 point, substitution and result: 1 point, **2 points** altogether.
Determination of R_{B2} : **1 point**.
- b) When determining R_{in} , formula: 1 point, substitution and result: 1 point, **2 points**.
When calculating R_{out} , formula: 1 point, substitution and result: 1 point, **2 points** altogether.
- c) When calculating A_u , formula: 1 point, substitution 1 point, **2 points** altogether.
- d) When calculating u_{in} , formula: 1 point, substitution and result: 1 point, **2 points** altogether.
Determination of u_{out} : **1 point** altogether.

Task 4

Maximum points: 15

- a) Maximum **4 points** can be allocated for the correct solution. Veitch diagram: 2 points, simplified function: 2 points. In the case of giving a form that is logically correct but it is not the simplest form: 1 point deduction.
- b) Maximum **3 points** for the correct solution. In the case of a logically correct solution containing more than seven gates: maximum 2 points.
- c) Maximum **4 points** for the correct solution. Defining the disjunctive canonical form: 2 points, simplification of the function: 2 points.
- d) Maximum **4 points** for the correct solution. Failing to give another form of the function does not result in deduction of points if the implementation is correct, with a maximum of 4 NAND gates. Maximum 3 points if solution is logically correct but contains more than 4 gates.

The allocation of the above-mentioned points takes into consideration quantitative aspects. Points calculated this way can be decreased to the extent indicated in the table if qualitative criteria are not met or the documentation of the task is not appropriate.